

Effects of the Consumption of *Macleaya cordata* Extract Preparation by Sows

R. A. Matulka^{1*}, J. Dohms²

¹Burdock Group Consultants, Orlando, FL, USA

²Phytobiotics Futterzusatzstoffe GmbH, Eltville, Germany

Email: *rmatulka@burdockgroup.com

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Abstract

Consistent feed intake during the stress of gestation and lactation in the sow may help maintain the wellbeing of the sow and resulting litter. The effects of the consumption of the appetizing ingredient *M. cordata* extract preparation (MCEP; trade name Sangrovit[®]) added to the feed at 50 and 100 ppm on the wellbeing and growth in the late gestation and lactation phases of sows and the resulting piglets prior to weaning was evaluated in preliminary and confirmatory feeding trials. Small increases in sow feed intake and piglet body weights were found in the preliminary trials. In the confirmatory field trial, low increases in sow feed intake with Sangrovit[®] resulted in decreased sow backfat loss and increased ($P < 0.05$) sow body condition scores. There was a positive effect on piglet growth, with significantly ($P < 0.05$) increased litter weight gain and litter weight at weaning. The results of these field trials show that the addition of Sangrovit[®] to sow feed during late gestation and lactation has positive effects on both the sows and the resulting litters.

Keywords

Macleaya cordata, Sangrovit[®], Sow, Flavor, Piglet

1. Introduction

Consistent feed consumption by the sow is critical to sustained health of the animal through the stressful time of gestation and lactation, as well as the health and growth of the piglets. A sow that maintains body weight during gestation/lactation will be in better health and more likely to achieve a healthy litter the next breeding cycle. Feeds are many times produced utilizing ingredients from different production facilities, different carriers, and/or the plant-derived ingredients are from different growing regions, any of which may alter the taste

of the feed. A key aspect to commercial swine production is the consistent consumption of feed throughout the growth process. Changes in the organoleptic qualities of the feed may often occur, either as stated above or when feed composition is changed as the pig moves from one life stage (e.g., piglet) to another (e.g., growing/finishing), which decreases overall feed intake [1] [2]. Piglets that were exposed to feed flavors prenatally through the maternal diet recognized the flavor during reexposure up to 23 days after birth, indicating that the addition of flavors or flavor modifiers to provide a consistent flavor profile can reduce inhibition of feed intake, resulting in less stress on the sow and on the piglets [3]. Plant-based organoleptic feed ingredients, such as essential oils, herbs and other phytochemical substances are being added to swine feed to help maintain or increase feed palatability and overall health and growth of the swine [4]. Sangrovit[®] is the trade name of a feed ingredient containing a *Macleaya cordata* extract (MCE) within a carrier (MCE preparation; MCEP), standardized to contain a minimum concentration of 1.5% sanguinarine in the final product. Sangrovit[®] provides a consistent flavor profile to feed, which helps maintain consistent feed intake over the life of the swine. Previous studies have evaluated the consumption of MCEP by growing and finishing swine [5] [6], with Sangrovit[®] added to the diet at 50 ppm providing a positive effect on body weight gain and feed conversion rate in weanling and growing swine [7] [8]; however, little is known on the consumption of Sangrovit[®] by sows during gestation and lactation. To that end, feeding trials have been conducted with Sangrovit[®] consumed in the diet by sows during the late gestation phase through piglet weaning.

2. Material and Methods

2.1. Preliminary Field Trials

For future preparation of a more controlled trial, two preliminary field trials were conducted in Vietnam that evaluated the addition of Sangrovit[®] to the diets of sows during gestation and lactation [9] [10]. The first preliminary trial (Trial #1) was conducted under field conditions in which the sows ($N = 9/\text{group}$; breed not specified) were fed either the control diet (nutrient/ingredient data not retained), or the control diet supplemented with Sangrovit[®] (100 ppm), starting two weeks prior to farrowing, until weaning at 28 days of age [9]. The control diet during the gestation phase contained chlortetracycline (3000 ppm), Bacitracine-Methylene-Disalicylate (500 ppm), copper-sulfate (25%, 100 ppm), De-odorase^{®1} (100 ppm) and a mycotoxin binder (specific binder not specified in the internal report; 1000 ppm). During the lactation phase, the control diet contained added amoxicilline (99%, 300 ppm), Bacitracine-Methylene-Disalicylate (500 ppm), copper-sulfate (25%, 100 ppm), De-odorase[®] (100 ppm) and a mycotoxin binder (specific binder not specified in the internal report; 1000 ppm).

The second preliminary trial (Trial #2) was conducted under field conditions in which the sows (Yorkshire/Landrace \times Duroc/Landrace cross breed; $N =$

¹Alltech, USA.

10/group) were fed either a control diet or the control diet to which Sangrovit[®] was added at 100 ppm feed [10]. The control diet formulation is provided in **Table 1**. The sows were fed with either the control or Sangrovit[®]—containing diet from four weeks prior to farrowing until weaning (average weaning age of the piglets: 25 days). Endpoints evaluated included: number of piglets/litter (total and live), piglet weight at birth and weaning, survival rate (%) and the daily rate of sick piglets (sickness parameters included evaluation of piglets for diarrhea, leg weakness and arthritis).

2.2. Confirmatory Field Trial

A confirmatory field trial (Trial #3) was conducted in Thailand using a least squares (LSD) design through two consecutive parities, utilizing 90 Yorkshire*Landrace sows (average initial body weight at 211 kg) [11]. The experiment consisted of two phases: late gestation and lactation. The basal diet provided to the sows during these two periods is provided in **Table 2**.

During the late gestation phase, second- and third-parity sows ($N = 30$ /group) were randomly allocated to three groups. Each block represented a similar initial farrowing date. The three groups were: 1) control basal diet, 2) control diet +

Table 1. Composition of basal diets, on an as fed basis (%) (Trial #2).

| Ingredients | Sow diets | |
|---------------------------------|----------------|-----------|
| | Late gestation | Lactation |
| Corn | 35.8 | 46 |
| Soybean meal | 14 | 16 |
| Rice bran | 25 | 15 |
| Broken rice | - | 11 |
| Wheat bran | 23 | 6 |
| Fish meal | - | 3 |
| DCP | 0.5 | 1.2 |
| Stone mill ¹ | 0.8 | 0.74 |
| Salt | 0.4 | 0.5 |
| Kemzyme ^{®2} | 0.1 | - |
| Premix 140 (mineral + Vitamins) | 0.25 | 0.25 |
| Copper Sulfate | 0.05 | 0.01 |
| Biotin | 0.1 | - |
| L-Lysine HCL | - | 0.15 |
| L-Threonine (98.5%) | - | 0.05 |
| Chlortetracycline | - | 0.1 |

¹Limestone; ²Kemzyme[®] = stabilized, multi-enzyme feed ingredient;
<https://kemin.com/eu/en/products/kemzyme>

Table 2. Composition of basal diets, on an as fed basis (%) in Trial #3.

| Ingredients (% of total diet) | Sow diets | |
|----------------------------------|----------------|-----------|
| | Late gestation | Lactation |
| Rice, broken | 30 | 29 |
| Corn | 22.7 | 22.7 |
| Rice bran | 35 | 34 |
| Soybean meal (44% protein) | 5.1 | 5.1 |
| Fish meal (55% protein) | 5 | 6 |
| Fat | 1 | 2 |
| Dicalcium phosphate (P18) | 1.6 | 1.6 |
| Salt | 0.35 | 0.30 |
| Premix | 0.25 | 0.30 |
| Total (%) | 100 | 100 |
| Crude protein (%) | 14 | 16 |
| Energy (Kcal/kg) | 3160 | 3250 |

Sangrovit[®] (50 ppm), and 3) control diet + Sangrovit[®] (100 ppm). The sows were housed in a confinement gestation facility and fed individually in stalls. The individual gestation stalls (2.1 m × 0.5 m) had 0.9 m of concrete in the front and 1.2 m of slotted floor (*i.e.*, 15.2 cm concrete slat and 2.5 cm slot) in the back of the stall. An average of 2.5 kg feed was provided to the sow daily. Body weight change and feed intake were recorded from Day 100 of gestation through farrowing (approximately Day 114).

At farrowing, the sows were placed in farrowing crates (2.1 m × 0.6 m) that had an area for the piglets (2.1 m × 0.5 m) on each side of the stall (lactation phase). The floor was woven wire and each crate contained an electric heat box (0.6 m × 0.3 m) in the pig area and a 0.6 m × 0.6 m rubber pad located below the sow shoulder area. The sows were kept to their original three groups, receiving their respective diets: 1) control, basal diet, 2) control diet + Sangrovit[®] (50 ppm), and 3) control diet + Sangrovit[®] (100 ppm). Sows were hand-fed the diet to appetite twice daily throughout the three-week lactation period. Changes in sow body weight and feed intake from farrowing to weaning at 21 days of piglet age were recorded. At 3 days of age, the litters were standardized to ten piglets/sow. Culled piglets were randomly selected and placed with another litter of similar age but not as part of the study. Within the experiment, the piglets remained in the same treatment groups defined by their dams. Piglet birth and weaning weights were recorded. Statistical analysis was conducted utilizing ANOVA procedure within SAS (1988)², with treatment effects tested for linear and quadratic responses. Pseudo standard error was utilized to evaluate significance [12].

²SAS Institute Inc., Cary, NC U.S.A.

3. Results and Discussion

3.1. Preliminary Trials

Sows fed Sangrovit[®] at 100 ppm from late gestation (two weeks before farrowing) through weaning of the resultant piglets (Day 28 post birth) in the first preliminary trial (Trial #1) resulted in a slightly increased feed intake by the sows (statistical analysis not conducted), which corresponded to increased piglet weights both at birth and at weaning (**Table 3**). The slight increase in sow feed intake may have resulted in increased milk production, which could have been the reason for the increased number of piglets reaching weaning age (**Table 3**).

The second preliminary trial (Trial #2) had an increased gestation period (four weeks feeding of control diet or control diet plus Sangrovit[®] at 100 ppm), but a slightly decreased weaning age (average of 25 days post birth), compared to the previous trial. Study results focused on piglet growth, with the apparent assumption that increased piglet health and growth parameters was dependent on better health of the sows fed 100 ppm Sangrovit[®] in the diet. The Sangrovit[®]-fed group had a higher number of piglets/sow (4.7% greater than control), which was correlated with a decreased body weight/piglet (**Table 4**). However, the weight at weaning (3.8%) and overall weight gain (5.4%) was increased, relative to values found in the control group, and a decreased percentage of piglets during the trial period (**Table 4**).

3.2. Confirmatory Trial

In the confirmatory trial (Trial #3), no differences in sow reproductive performance were observed among the dietary treatments (**Table 5**). Average daily feed intake (ADFI) was slightly increased with increasing concentrations of Sangrovit[®], although the increases did not reach statistical significance ($P > 0.05$). Although there were no significant differences between treatment groups and the control group on sow body weight change from Day 0 through sow weight at weaning ($P > 0.05$), there was an observable inhibition of a decrease in body-weight between dose groups, which was also reflected in an inhibition of decreasing change in sow back fat (**Table 5**). At the start of the study (Day 100 of gestation), the sow body condition score did not differ ($P > 0.10$). Overall, the

Table 3. Effect of Sangrovit[®] consumption by sows on piglet growth (Trial #1).

| Parameter | Control | Sangrovit [®] (100 ppm) | Difference (%)* |
|---|---------|-------------------------------------|-----------------|
| Piglets born/litter | 9.78 | 9.78 | 0 |
| Piglets weaned/litter | 8.78 | 9.22 | 5.01 |
| Birth weight (kg/piglet) | 1.86 | 1.95 | 4.84 |
| Weaning weight (kg/piglet) | 7.04 | 7.57 | 7.53 |
| Feed intake during lactation (kg feed/sow/day) | 6.39 | 6.5 | 1.72 |

*Percent relative to control.

Table 4. Piglet growth and survival during lactation on sows consuming Sangrovit diet (Trial #2).

| Parameter | Control | Sangrovit® (100 ppm) | Difference (%)* |
|-----------------------------------|---------|-------------------------|-----------------|
| Number of piglets born per litter | 11.7 | 11.8 | 0.9 |
| Piglets born alive per litter | 10.7 | 11.2 | 4.7 |
| Birth weight (kg/piglet) | 1.82 | 1.80 | -1.1 |
| Weight at weaning (kg/piglet) | 7.80 | 8.10 | 3.8 |
| Weight gain (kg/piglet) | 5.98 | 6.30 | 5.4 |
| Daily rate of sick piglets (%) | 6.70 | 2.60 | -61.2 |
| Survival rate (%) | 96.26 | 98.21 | 2.0 |

*Percent relative to control.

Table 5. Effect of Sangrovit® in lactation diets on sow performance (Trial #3).

| Variable | Sangrovit (ppm) | | | PSE |
|--|-----------------|-------|-------|------|
| | 0 | 50 | 100 | |
| No. of sows | 30 | 30 | 30 | - |
| Parity | 3.5 | 3.3 | 3.2 | 0.15 |
| Lactation length, day | 21.51 | 21.35 | 21.22 | 0.24 |
| ADFI, kg | 6.13 | 6.69 | 6.74 | 0.39 |
| Sow weight at d 0, kg | 224.6 | 214.5 | 232.9 | 6.12 |
| Sow weight at weaning, kg | 219.9 | 210.8 | 230.1 | 6.23 |
| Sow weight change, kg | -5.7 | -4.37 | -2.86 | 2.89 |
| Sow backfat at d 0, mm | 16.3 | 16.1 | 16.5 | 0.43 |
| Sow backfat at weaning, mm | 14.5 | 14.6 | 15.3 | 0.41 |
| Sow backfat change, mm | -1.9 | -1.5 | -1.2 | 0.25 |
| Sow body condition score | 3.1a | 3.5b | 3.4b | 0.2 |
| Wean-to-estrus interval | 6.9 | 5.4 | 5.6 | 0.73 |
| Sows returning to estrus before 7 days post weaning (%) | 93 | 96 | 96 | - |

^{ab}Means within a row with different superscripts differ ($P < 0.05$); PSE = Pseudo Standard Error; analyzed as least square means.

body condition scores for the sows consuming diets containing 50 and 100 ppm Sangrovit® were significantly ($P < 0.05$) greater than the control group, indicating that even a small increase in feed intake has a positive effect on the maintenance of the sow during late gestation and lactation phases of the life cycle.

The inclusion of Sangrovit® in the sow diets had no effects on farrowed litter size or the litter size at weaning (Table 6), but the percent mortality prior to weaning was significantly ($P < 0.05$) decreased in the groups fed Sangrovit®, compared to the control group. The increased consumption of feed by the sows had a positive effect on the growth of the piglets, resulting in significantly ($P <$

Table 6. Effect of Sangrovit® in sow lactation diets on litter performance (Trial #3).

| Variable | Sangrovit (ppm) | | | PSE |
|----------------------------------|--------------------|---------------------|--------------------|------|
| | 0 | 50 | 100 | |
| No. of sows | 30 | 30 | 30 | - |
| Litter size(alive) | 10.8 | 10.2 | 10.2 | 0.13 |
| Litter size at weaning | 9.5 | 9.7 | 9.8 | 0.08 |
| Piglet pre-weaning mortality (%) | 9.13 ^a | 6.86 ^b | 6.45 ^b | 1.38 |
| Litter weight at birth (kg) | 16.06 | 15.79 | 15.90 | 0.68 |
| Litter weight at weaning (kg) | 54.16 ^a | 56.59 ^b | 58.67 ^b | 1.88 |
| Litter weight gain (kg) | 38.10 ^a | 38.20 ^{ab} | 42.75 ^b | 2.21 |
| Piglet ADG (g) | 190 | 199.2 | 199.4 | 0.01 |

^{ab}Means within a row with different superscripts tend to differ ($P < 0.05$); PSE = Pseudo Standard Error; analyzed as least square means.

0.05) increased litter weight gain and litter weight at weaning.

Evaluation of the piglet growth during the study found that sow consumption of Sangrovit® had no effect on piglet growth seven days after birth, but by 14 days the addition of Sangrovit® to the sow diet significantly ($P < 0.05$) increased piglet body weight (Table 7), and was maintained until the end of the study (*i.e.*, weaning at Day 21).

Small increases in sow feed consumption can have significant effects on piglet growth, presumably through increased milk production, as the piglet weight gain from birth through Day 7 of life was significantly increased in the sow groups fed Sangrovit® at both 50 and 100 ppm, compared to the control group. The positive piglet weight gain was maintained through weaning (Table 8).

4. Conclusion

Field trials are able to provide an indication of potential effects of the addition of flavoring ingredients to swine feed. Trials were conducted on the addition of Sangrovit®, a phytogenic feed ingredient on the growth and health of sows during late gestation and lactation and their piglets found slight increases in feed intake by the sows in the preliminary trials and corresponding increases in piglet body weights prior to weaning. The results from these field trials (e.g., decreased mortality, increased piglet body weight) indicate that consistent feed consumption by the sows also helped maintain the health of the piglets. In the confirmatory trial, even this slight increase in feed intake resulted in increased sow body condition score and an inhibition of the decrease in sow back fat, an indicator of sow health. Increasing concentration of Sangrovit® in the diet decreased the loss of sow body weight during the study, while maintaining the growth and well-being of the piglets, as indicated by increased litter weight at weaning and overall litter weight gain. These field trials show that Sangrovit® fed to sows during late gestation and during lactation help to maintain the health of the sows and the

Table 7. Piglet body weight from day at birth to weaning (Trial #3).

| Treatment | piglet (n) | Body weight (kg)* | | | |
|----------------------------------|------------|-------------------|-------------|--------------------------|--------------------------|
| | | Birth Weight | Day 7** | Day 14 | Day 21# |
| control | 95 | 1.57 ± 0.37 | 2.33 ± 1.03 | 3.16 ± 1.55 ^a | 6.03 ± 1.43 ^a |
| Sangrovit [®] (50 ppm) | 97 | 1.43 ± 0.46 | 2.43 ± 0.91 | 3.74 ± 1.92 ^b | 6.48 ± 1.44 ^b |
| Sangrovit [®] (100 ppm) | 98 | 1.49 ± 0.41 | 2.16 ± 0.85 | 3.61 ± 1.78 ^b | 6.49 ± 1.57 ^b |
| average | N= 290 | 1.41 ± 0.43 | 2.30 ± 0.90 | 3.61 ± 1.82 | 6.24 ± 2.48 |

*Mean ± SD. ^{ab}Means within a row with different superscripts tend to differ ($P < 0.05$); **Day indicates day of age; #Day 21 was date of weaning.

Table 8. Piglet weight gain from birth - Day 7 of age and from Day 7 - Day 21 (weaning) (Trial #3).

| Treatment | Weight gain (g/d)* | | Mortality rate (%)** |
|----------------------------------|------------------------------|------------------------------|----------------------|
| | Birth - Day 7 | Day 7 - Day 21 | |
| Control | 121.14 ± 118.56 ^a | 190.00 ± 95.50 ^a | 6.0 ^a |
| Sangrovit [®] (50 ppm) | 137.04 ± 100.72 ^b | 209.22 ± 98.97 ^b | 4.3 ^b |
| Sangrovit [®] (100 ppm) | 152.22 ± 91.70 ^b | 211.49 ± 104.09 ^b | 4.5 ^b |
| Average | 136.69 ± 99.70 | 201.81 ± 100.22 | 4.6 |

*Mean ± SD. ^{ab}Means within a row with different superscripts tend to differ ($P < 0.05$); **Piglet mortality rate calculated from birth to Day 7.

resulting piglets. Future rigorous, placebo-controlled, randomized and blinded studies that are statistically evaluated would be helpful in confirming the results of these field trials.

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